Damaged evaluation of trees using near infrared and thermal infrared

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ABSTRACT: In Japan, we conducted a large-scale expanded afforestation plan for post-war reconstruction. About 70 years passed since then, trees have weakened, so many fallen-tree accidents occurred. There are visual observations and palpations by tree doctors, but this method spends a lot of time and cost. Therefore, it is necessary to have a simple and low cost method for diagnosing the growth of trees. In this research utilized near infrared responsive to plants and highly effective thermal infrared for detection of stem cavities and corroded parts. Taking pictures of trees using near-infrared cameras and thermographic cameras, we periodically obtained image data. We analyzed from the photographed image and selected trees with high risk of fallen trees. Image analysis revealed that the NDVI value varies depending on the incident amount of sunlight. Therefore, I corrected the NDVI value by sunlight. As a method, a correction formula derived from the correlation between the amount of change in NDVI value and the amount of change in solar radiation amount. As a result, it was possible to calculate the correction of the NDVI value even when the sunlight incident amount is different. As a result of image analysis, it was possible to select trees with high risk and to detect decaying parts of trunk from pine trees. In the future, environmental noise of sunlight and outside air temperature is a problem, so further correction algorithms need to be developed. In addition, it is necessary to increase the shooting frequency of trees and observe the seasonal change of trees.

1. INTRODUCTION

In Japan, we conducted a large-scale expanded afforestation plan for post-war reconstruction. About 70 years passed since then, trees have weakened, so many fallen-tree accidents occurred. On November 3, 2016, a woman was seriously injured by a fallen tree near Nojiri lake in Nagano prefecture. Such this cases are rapidly increasing in recent years. Therefore, trees that have become aged and large trees are very dangerous. In such a situation, visual observations and palpations by tree doctors as a method of tree vegetation diagnosis.However this method spends a lot of time and cost. Therefore, it is considered necessary to make efficient and physical diagnosis to make judgment based on quantitative and scientific basis. In this research, we shoot trees using near infrared camera, thermal infrared thermography camera.The effectiveness of damaged evaluation of trees using both cameras was examined from the analysis of image data.

2. EXPERIMENT METHODS

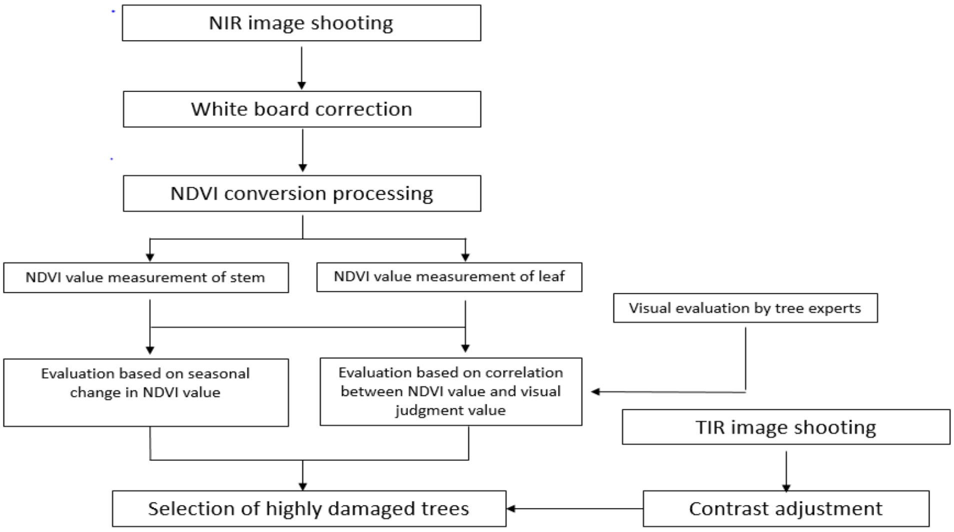
In this research, Photographs were taken using a near-infrared camera (ADC 3, manufactured by TETRACAM, USA) (FIG. 1) and a thermal infrared thermography camera (InfReC R 300 SL-S, manufactured by Nippon Avionix Co., Ltd.) (FIG. 2). As areas subject to experiments, Hokuriku Expressway-ataka PA, amagozen PA, and Kanazawa Institute of Technology amaike Campus, 17 cedars, 26 cherry trees, 19 pines were targeted. In order to prevent confusion with other trees, we managed the location of trees on GIS. (FIG. 3) Near infrared image was analyzed using near infrared image processing software (Pixel wrench 2) and thermal infrared image was analyzed by thermal infrared image processing software (InfReC Analyzer). The near infrared image was subjected to NDVI conversion processing after whiteboard correction and the NDVI value was calculated. The thermal infrared image, after contrast adjustment, determines the temperature characteristics and corroded portion of the trunk. The trees were sorted out in 5 grades by visual judgment of tree experts.The effectiveness of this research will be clarified from the correlation between the evaluation of trees by visual observation and the evaluation by near infrared and thermal infrared.

Figure 1 ADC 3

Figure 2 InfReCR 300 SL-S

Figure 3 Experiment area

Table 1. Experiment flow



3. ANALYSIS RESULT AND CONSIDERATION

3.1 Amount light correction of NDVI value

The NDVI value changes greatly depending on the amount of light incident on the camera. (FIG.4, 5) Therefore, correction by amount of light must be performed. Therefore, pine trees of a healthy tree were photographed and analyzed, and a correction calculation formula was calculated. The shooting method was taken from 8 directions every hour for the time period of 8:30 to 16:30, and the NDVI value and amount of light were acquired. Transition graphs of amount light and NDVI value are shown in FIGS. 6 and 7.

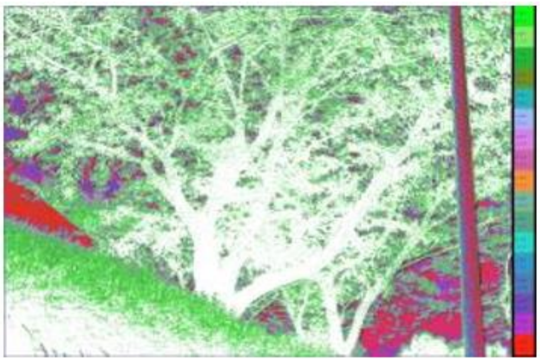


Figure 4 lux value:650lux Shooting date 2016/6/20

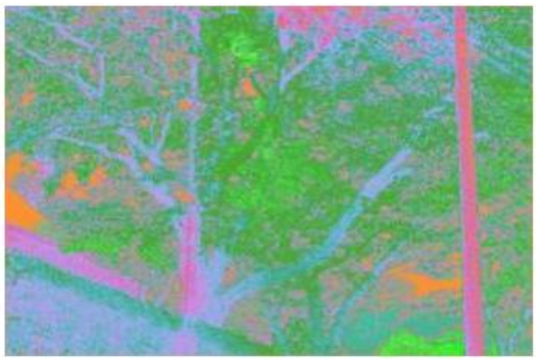


Figure 5 lux value:180lux Shooting date 2016/7/28

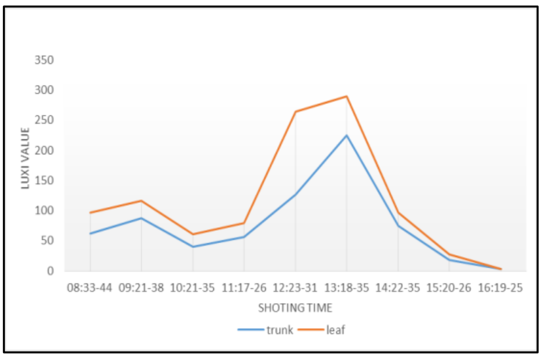


Figure 6 lux value transition

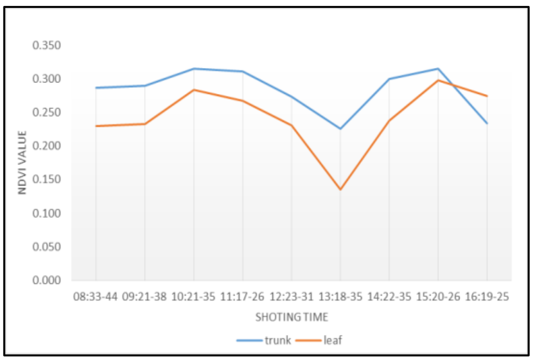


Figure 7 NDVI value transition

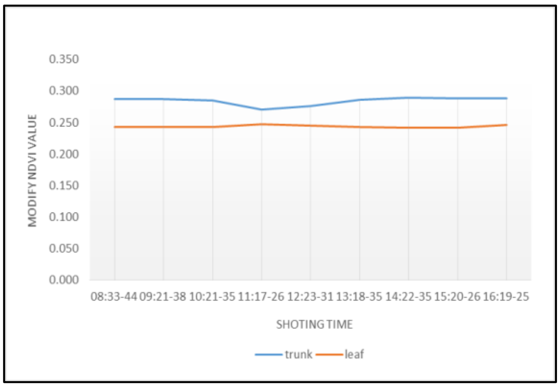


Figure 8 modify NDVI value

NDVI correction formula derived using light quantity and NDVI value is shown below. By this equation, NDVI value correction became possible as shown in Fig5.

$$Modify\ NDVI=-0.050281*LUX+0.268141$$

3.2 Analytical results and considerations in near infrared

Pine trees are evergreens, so healthy pine is leaf of green throughout the year. However, the pine infected with pine wilt disease is mostly withered in October. Infected pine leaves wither red. Therefore, the near infrared reflectance decreases and the reflectance in the red band rises. From this relationship, it can be expected that the NDVI value will be low. From the above, pines with high possibility of infection were extracted from the analysis result. Scatter diagrams of pines vitality value and NDVI value of ataka PA in September and October are shown in Figures 9 and 10. In September NDVI value was within 0 to 0.1 except No. 11, whereas in October it was divided into trees within 0 to 0.05 and trees within 0.15 to 0.2. Therefore, we thought that we could choose as healthy trees or bad trees in October, when the pine withers. Changes in NDVI values of selected trees are shown in Fig. 11 and 12

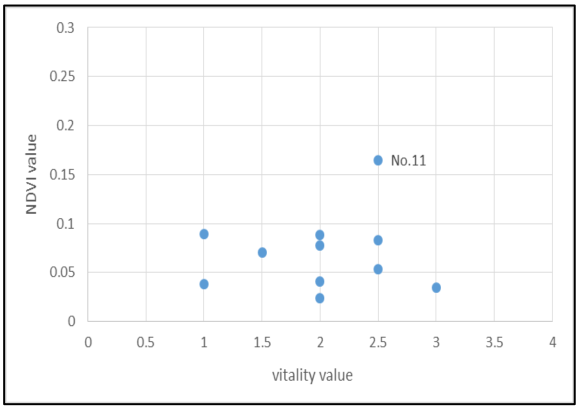


Figure 9 NDVI value and vitality value (September)

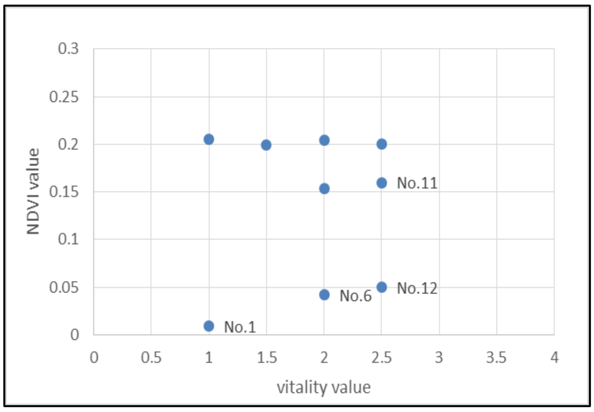


Figure 10 NDVI value and vitality value (October)

In September NDVI value was within 0 to 0.1 except No. 11, whereas in October it was divided into trees within 0 to 0.05 and trees within 0.15 to 0.2. Therefore, we thought that we could choose as healthy trees or bad trees in October, when the pine withers. Changes in NDVI values of selected trees are shown in Fig. 11 and 12 For trees selected as healthy trees, the NDVI value declines from June to July, and the NDVI value then increases (Figure 11) For trees selected as bad trees, the NDVI value declines from June to July, and thereafter are almost constant values. (Figure 12) From this, pine was characterized by the transition of NDVI value from July. A tree whose NDVI value rises is a healthy tree, and trees that keep constant are judged to be defective trees.

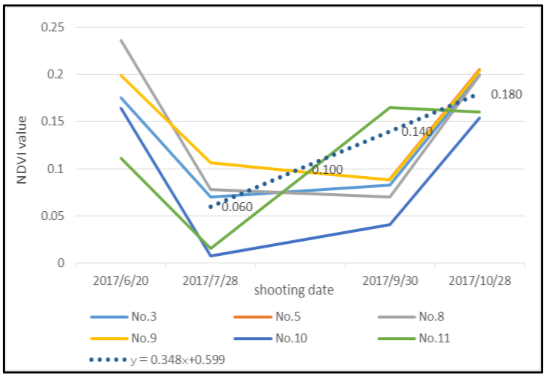


Figure 11 Judge as a bad tree

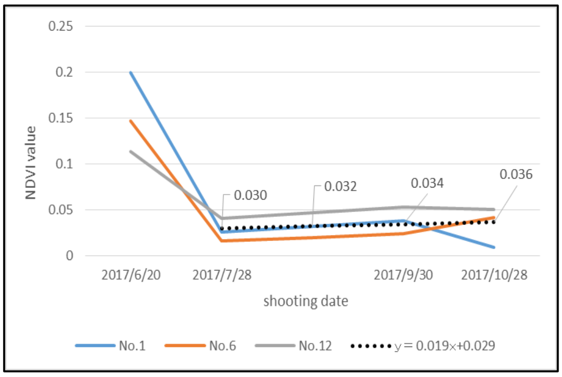


Figure 12 Judge as a healthy tree

3.3 Analytical results and considerations using thermal infrared

The cedar trunk was photographed and analyzed using thermal infrared in amaike (FIG.13). The thermal infrared image was divided into colors by contrast adjustment (FIG. 14).Comparing Fig. 13 with Fig. 14, it was found that the temperature of the corroded portion of the trunk stem was lower than the temperature of the other portion. The corroded part of the tree trunk has high hollow volume and moisture content. Therefore, we thought that there was a high temperature change. According to expert judgment, this tree proved to be a defective tree. From the above, it is highly possible to judge the deterioration of stem using thermal infrared.

Figure 13 Corrosion part of cedar

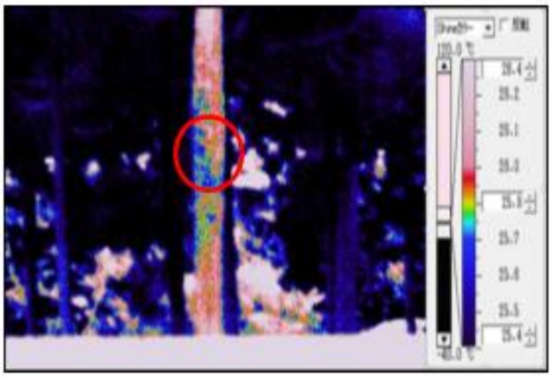


Figure 14 Thermal infrared image (after contrast adjustment)

4. CONCLUSIONS

In this research, we attempted to evaluate the damage of trees using near infrared and thermal infrared. By using near infrared, it was possible to select defective trees from the analysis results of pine leaves. By using thermal infrared, it was found that there was a temperature difference in the corroded part of the trunk. From the above, it is expected that the effectiveness of tree damage assessment by this research can be expected. However, it is a subject to be susceptible to environmental noises such as sunlight and ambient temperature, so further correction algorithms need to be developed.

REFERENCES

1) General Foundation Japan Greenery Center: Revised 4th edition of Newest · Tree Doctor, p594, 2015.6.30

2) Nihon Keizai Shimbun (Japanese newspaper) : Female injured by fallen tree injured 2016.11.3 Published

3) Kobe University Faculty of Agriculture Forest Resources Laboratory Keiko Kuroda: Why do trees die when nematodes infect, FOREST PESTS Vol.52 No.2, P.19-26, 2003